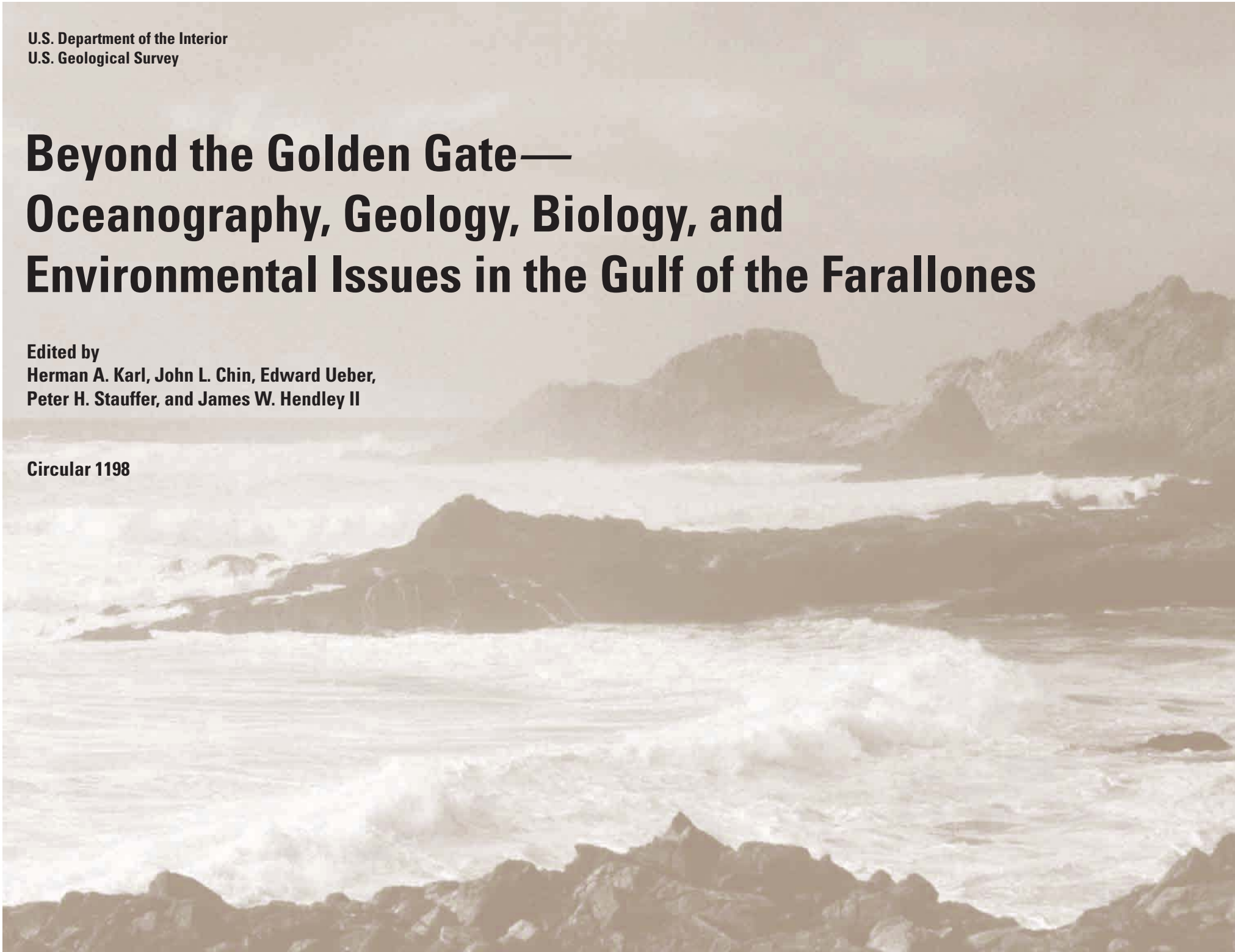


U.S. Department of the Interior  
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# **Beyond the Golden Gate— Oceanography, Geology, Biology, and Environmental Issues in the Gulf of the Farallones**

Edited by  
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## Biology and Ecological Niches in the Gulf of the Farallones

# Salmon

Peter Adams

Two species of salmon—chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*)—are commonly found in the Gulf of the Farallones. Chinook salmon fishing is the activity that brings the most people out on the waters of the gulf. In 1995, the chinook fishery in the gulf was valued at more than \$24 million.

Chinook (or king) salmon are key predators in the gulf, and their distribution and occurrence are related to their seasonal diet cycle. Most chinook salmon found in the gulf are 3-year-old fish returning from the open ocean that are preparing to enter the Sacramento River system, where they will spawn and then die. After the eggs hatch the following spring, the juvenile salmon will grow for 7 months in freshwater. They then migrate to the ocean, where they will live for 2 years before returning to the gulf. Coho (or silver) salmon along the California coast are listed as a threatened species under the Endangered Species Act, and their capture has been prohibited since 1993. Native-run (versus hatchery) chinook salmon are also a candidate for a threatened-species listing.

Chinook salmon returning from the open ocean move into the Gulf of the Farallones in February and March, when they are found off the Golden Gate from Boli-

nas Point in the north to Point San Pedro in the south. While in this area they feed almost equally on Pacific herring and anchovies. The herring have just migrated back to their feeding grounds outside of the Golden Gate from San Francisco Bay, where they spawned from November through February, and anchovies are gathering in nearshore waters before moving into the bay beginning in April.

In April, chinook salmon are found from north of the Golden Gate to Point Reyes and offshore to the Farallon Islands. There they feed on invertebrates, largely the euphausiid shrimp (krill) *Thysanoessa spinifera*. Krill are taken as prey from surface and subsurface swarms that occur over a wide area of the gulf during April and May. The pink to orange color of salmon flesh during this period is due to a carotenoid pigment in the exoskeleton of the krill (for more information, see chapter on Krill). This flesh color has become so popular that now there are fisheries for krill, which are freeze-dried and fed to pen-reared salmon as a finishing product to produce this color.

For a brief 2- or 3-week period in April, the chinook's diet is dominated by the megalopa larvae of the Dungeness crab (*Cancer magister*) (see chapter on Free-

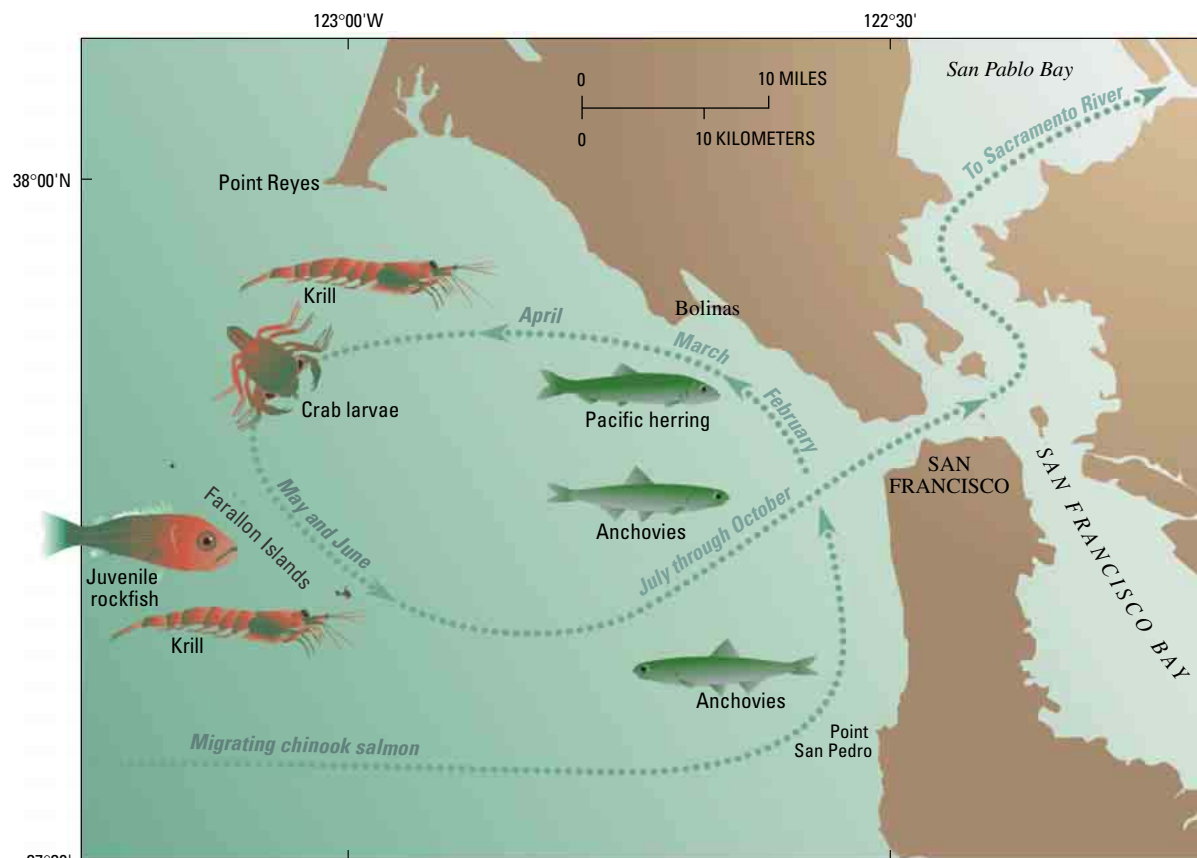
Floating Larvae of Crabs, Sea Urchins, and Rockfishes). These larvae are the last pelagic (free-floating or swimming) stage before the crabs sink to the bottom and take on their adult shape. More than 7,000 Dungeness megalopa have been found in a single chinook-salmon stomach.

In May and June, chinook start feeding on krill and juvenile rockfish offshore near the Farallon Islands. These rockfish are late pelagic-stage fish that as adults will migrate to bottom habitats. In years when juvenile rockfish are abundant, they are the preferred prey and dominate the chinook diet during these months, whereas in low-abundance years, chinook salmon feed mainly on krill.

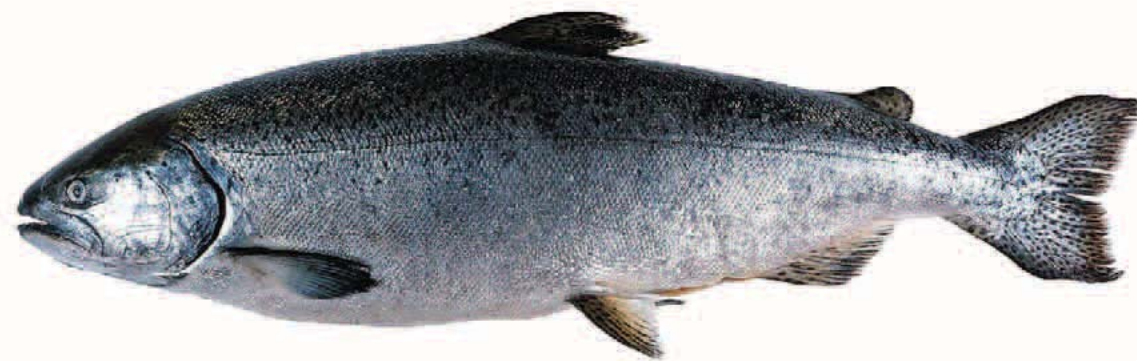
Sometime between mid-June and mid-July, the chinook salmon abruptly move from near the Farallon Islands to directly in front of the Golden Gate, the so-called "middle grounds." Here, chinook salmon feed exclusively on anchovies, which had moved into San Francisco Bay in May and June to begin spawning in the warmer water. After June, when the water in the gulf warms up because of the absence of cold upwelled water, anchovies move out of the bay and into the gulf where they continue spawning into October. Chinook Salmon remain in front of the Golden

Gate until October, but in lower and lower concentrations as they move up the Sacramento River system to spawn. The following February, the next year's 3-year-old chinook salmon begin to enter into the gulf, and the cycle begins again.

During strong El Niño years, the normal sequences of chinook salmon prey do not develop because the large increase in ocean temperature disrupts the prey's normal behavior. As a result, the aggregations of salmon that feed on these prey do not form, and chinook salmon of a given length weigh much less than normal. California's commercial salmon catch also drops severely, and the recreational catch is far below average.



As shown in this simplified diagram, 3-year-old chinook salmon returning from the open ocean move into the Gulf of the Farallones in February and March and feed on Pacific herring and anchovies off the Golden Gate from Bolinas Point in the north to Point San Pedro in the south. In April, they feed on invertebrates, largely the euphausiid shrimp (krill) *Thysanoessa spinifera*. For a brief 2- or 3-week period in April, the chinook salmon's diet is dominated by larvae of the Dungeness crab (*Cancer magister*). In May and June, chinook salmon start feeding on krill and juvenile rockfish near the Farallon Islands. Sometime between mid-June and mid-July, chinook salmon abruptly move from near the Farallon Islands to directly in front of the Golden Gate, the so-called "middle grounds." Here, chinook salmon feed exclusively on anchovies. Chinook salmon remain in front of the Golden Gate until October, but in lower and lower concentrations as they move up the Sacramento River system to spawn. The following February, the next year's 3-year-old chinook salmon begin to enter into the gulf, and the cycle begins again.



A chinook salmon (*Oncorhynchus tshawytscha*). Most chinook salmon found in the Gulf of the Farallones are 3-year-old fish that are returning from the open ocean and preparing to enter the Sacramento River system, where they will spawn and then die. (Photograph from U.S. Food and Drug Administration.)



Chinook salmon fishing is the activity that brings the most people out on the waters of the Gulf of the Farallones. This large salmon was caught in the gulf. (Photograph from National Marine Fisheries Service.)